

EXECUTIVE SUMMARY

This report documents the results of an IV&V engineering analysis of TRW study 94-2 on EDOS facility consolidation. The objective is to assess the completeness and validity of the TRW study and determine if it provides an adequate basis for the Government to make a decision on consolidation of EDOS facilities. The TRW study addressed all elements of the Task Assignment but does not attempt to identify requirement changes that would facilitate consolidation. Hardware changes and facility impacts are addressed fully and adequate detail is provided to justify the conclusions reached. However, hardware cost impacts cannot be validated because insufficient cost data is presented. Software changes are not presented in enough detail and therefore software cost impacts cannot be independently validated. Overall, 6 of 12 areas addressed in the study do not provide sufficient information to support the conclusions reached. Therefore, we do not believe the study provides an adequate basis for NASA to choose among the alternatives.

1.0 CUP REPORT 94-2 REVIEW

1.1 INTRODUCTION

The purpose of this effort is to provide an engineering analysis of the TRW Contract Understanding Period Study number 94-2 on EDOS facility consolidation. The text for Task Assignment 94-2 reads as follows:

Analyze Impacts of Facility Consolidation

a) The contractor shall analyze the technical and programmatic implications of developing a consolidated EDOS system. This analysis shall identify impacts to the baseline EDOS architecture, existing external and internal interfaces, changes to the negotiated baseline functions in terms of effort, material, ODC, and implementation schedules, including integration, testing and transition to operation activities.

b) The contractor shall assess the feasibility and impacts of a consolidated EDOS system on each of the EDOS facilities and develop preliminary equipment layouts. The contractor shall analyze existing EDOS requirements against each of the consolidated facilities and identify either external dependencies or requirements that require modifications. The contractor shall document any impacts on the existing EDOS operations concept and provide projections on required operations staff.

The TRW study report analyzed is dated November 4, 1994 and contains 92 pages. Most of the report consists of bulletized presentation charts.

The specific objectives of this analysis are to answer the following questions:

1. Does the study address all elements of the Task Assignment? Do they answer all the questions?
2. Are the assumptions valid?
3. Does the study identify all of the technical and cost impacts?
4. Does the study consider requirement changes that would be appropriate?
5. Are the answers valid? Can the derivation of the answers be validated?
6. Should the study have addressed additional or different topics?
7. Does the study provide an adequate basis for NASA to make a selection?

1.2 METHODOLOGY AND APPROACH

The initial step in the methodology was to define the objectives for the analysis. This resulted in the 7 questions listed in Section 2. The analysis effort was structured to correspond to the Task Assignment. The task assignment was parsed into a set of elements (sentences and phrases). These Task Assignment elements are given in bold print in Section 4 to introduce the analysis results in each area. The study report charts were mapped to the Task Assignment elements to

determine if all aspects of the Task Assignment were covered (question 1). Then, for each element of the Task Assignment we assessed if the study results were valid and if the results could be validated *based on the information presented* (question 5). In parallel with the validity assessment the assumptions were reviewed, completeness of cost and technical impacts and possible requirement changes were evaluated. On completion of the element by element analysis, we looked at the study report as a whole to see if additional topics should have been considered and if the study provides an adequate basis for selection of an alternative.

In the analysis below [n] is a reference to chart n of the TRW report.

1.3 RESULTS

Analyze Impacts of Facility Consolidation

a) The contractor shall analyze the technical and programmatic implications of developing a consolidated EDOS system.

The report addresses consolidation of DIF with DPF into a CPF. It does not look at consolidation of the SEF with the DIF, DPF or CPF. [6]

The report assumes RL data formats to the EDOS CPF are identical to the TGT interface. (High rate RL data formatter is 150 Mbps serial clock and data). It does not consider data format change between TGT and CPF. This is left for the bent pipe study 94-7. [6] This means that some of the questions raised in investigating a CPF cannot be answered within this study but are given in 94-7.

This analysis shall identify impacts to the baseline EDOS architecture,

The report presents a set of high level services diagrams and system architecture diagrams for:

- the baseline EDOS,
- a generic Central Processing Facility (CPF),
- a CPF located at the White Sands Complex (WSC)
- and a CPF located at Fairmont, West Virginia (WVA).

The diagrams are presented at a high level but convey the essential architectural elements and the architectural differences between the consolidation options considered.

(Hardware)

The report states that the high and low rate switches must be resized if the CPF is located away from WSC [14, 39]. It does not explain why this is necessary. The justification for this change should be presented.

The hardware components and numbers of units for the DIF, DPF, SEF baselines and the CPF are presented in tables organized by major system function (OMF, CIF, SSF, etc.). Hardware is itemized at the level of major components (workstations, processors formatters, disk arrays, etc.) with the number of units of each component listed. Hardware architecture diagrams for CPF, DIF deletions, DPF deletions, and SEF with CPF testbed are presented. The DIF and DPF hardware architecture charts have cross hatching to indicated deletions. A summary table listing component

hardware deletions is not provided. The hardware detail presented is adequate to understand the facility floor space implications of the various options. However, the hardware cost reductions resulting from consolidation are rolled up and a single cost number is presented. Without additional breakout the cost reduction cannot be validated.

(Software)

The report concludes that changing the architecture to a CPF at WSC produces no reduction in SLOC. It does not provide detailed backup to support this conclusion. It states that some software items that are deleted due to consolidation are still needed elsewhere because they are dual use. Placing the CPF at WVA creates a need for 2000 SLOC of additional code. The report does not list the EDOS software components. The level of detail provided for software is not sufficient to verify their conclusion.

identify impacts to the existing external interfaces

The report lists the external interface impacts resulting from placing the CPF at WSC. They conclude that a CPF at WSC does not present any external interface issues.

Placing the CPF at WVA creates a set of major issues that affect key EDOS requirements. The issues identified are the ability to meet the low rate data latencies and the ability to support space-to-ground protocols. The impacts affect the interfaces with the TGT, Ecom and the EOC. Several other interfaces are dependent on the WSC to WVA high rate link. The study did not look at possible EDOS requirement changes that would reduce or eliminate these issues. For example, the study states that the "extra hop" through WVA causes delays that make it impossible to meet the 2 second EDOS/Ecom portion of the 5 second loop delay. They do not present estimates of what the latency would be if FL services were located at WVA. It is not clear if the 2 second latency requirement is missed by a small amount or a large amount. The study does not consider the option of relaxing the loop delay requirement. Nor did the study consider imposing additional requirements on Ecom to facilitate forward link processing at WVA.

It is not clear why more EOC retransmissions would be required [35] if the availability requirements are met.

identify impacts to the internal interfaces,

The report lists two internal interfaces that are eliminated by consolidation at a generic CPF. The file transfer interface between the DIF and the DPF, and the inter-site OMF interfaces for service control and status.

changes to the negotiated baseline functions in terms of effort, material and ODC,

The total EDOS development cost savings for the WSC CPF option [48] is given as \$3.3M. The cost impact of the CPF at WVA is not given because of areas of uncertainty (addressed in study 94-7). The report does not provide sufficient detail to independently validate the cost impact. This cost reduction does not include O&M savings although O&M staffing reductions are presented. Impacts to external systems and networks are listed but not costed.

changes to the negotiated baseline functions in terms of implementation schedules, including integration, testing and transition to operation activities.

The report states that consolidation at WSC or at WVA requires no changes in implementation schedule because there are no reductions in EDOS functionality. However, the report does say that system integration and test are simplified by consolidation. The report does not provide sufficient detail to verify the lack of an impact on implementation schedule. Schedule impacts on external systems or those resulting from resolving the impacts of a WVA CPF are not addressed.

b) The contractor shall assess the feasibility and impacts of a consolidated EDOS system on each of the EDOS facilities

The report gives facility requirement impacts for a generic CPF, a WSC CPF, and a WVA CPF. The floor space requirements for the baseline architecture and the CPF architecture are given in the following table.

Facility	Square Feet	No. Desks	No. Units
CPF	3468	21	92
DIF	2964	17	81
DPF	1932	15	43
SEF non-testbed	4260	53	45
Total Baseline	9156	85	169
DIF+DPF+SEF			
CPF + SEF	7728	74	137
Delta	(1428)	(11)	(32)

The impact of consolidation on EDOS facilities is fully addressed. The facility calculations presented are straight forward and sufficient detail is provided to verify the results. The assumptions seem reasonable. Consolidation at a CPF reduces floor space requirements by 1428 square feet. This is a reduction of 29% of the baseline DIF plus DPF floorspace. Desk units take 60 square feet and equipment units take 24 square feet. Desks units are reduced in proportion to staffing levels which means that 46% of the space saved comes from staffing reductions and the remaining 54% from equipment reductions.

develop preliminary equipment layouts.

Equipment layouts are presented based on square footage requirements for desks and equipment units within each major EDOS functions, i.e., they present the space required for each major function as a contiguous rectangular area. They layout diagrams do not show individual pieces of equipment. This approach is adequate and avoids confusing the diagrams with unnecessary detail.

The contractor shall analyze existing EDOS requirements against each of the consolidated facilities and identify either external dependencies or requirements that require modifications.

The report indicates the overall F&PS document changes that will be needed. It does not consider the possibility of modifying key requirements that are obstacles to consolidation. External dependencies are presented as impacts to the external interfaces.

The contractor shall document any impacts on the existing EDOS operations concept

Impacts to the Operations Concept are presented for each of the three consolidation options (Generic CPF, WSC CPF and WVA CPF). The WVA CPF impacts include making the EOC commanding more complex due to increased retransmissions and longer contacts [35, 44]. However, they do not provide the reasons why these impacts will be felt.

[27] says that most changes to the generic CPF operations concept are the same for the WSC CPF. Which ones aren't the same?

provide projections on required operations staff.

The following table summarizes the O&M staffing estimates for the baseline EDOS and for the generic CPF.

	96	97	98	99	00
DIF	13	17	28	27	27
DPF	13	17	28	27	27
SEF	0	0	30	37	37
Baseline	26	34	86	91	91
CPF	16	21	64	70	70
Delta	(10)	(13)	(22)	(21)	(21)

Staffing impacts of consolidation are fully addressed. There is sufficient detail to follow the derivation of the results. Results imply a significant savings in O&M resulting from consolidation. The impact of consolidation at WVA was not computed due to lack of technically feasible solutions for link management, fault coordination and user coordination. Study 94-7 addresses staffing requirements associated with TDRSS Bend-Pipe solution. Since the study did not address consolidation of the SEF with the DIF and DPF no staffing reductions are realized at the SEF. The SEF O&M staffing is 41% of EDOS O&M staffing without consolidation and 53% of staffing when the DIF and DPF are consolidation.

1.4 CONCLUSIONS AND RECOMMENDATIONS

The TRW report is in view graph format except for appendices. While this format is convenient for presentation purposes it is not adequate to convey the supporting details needed to substantiate the conclusions reached. In many cases, key conclusions cannot be validated based on the information presented. The study report should be done in normal document format.

The following are the conclusions and recommendations for each of the questions listed in our objectives:

1. Does the study address all elements of the task SOW? Do they answer all the questions?

The TRW study report addressed all elements of the SOW except for identification of EDOS functional and performance requirement changes that would facilitate consolidation. For example, changes to the EDOS latency requirements were not considered.

2. Are the assumptions valid?

The assumption that the CPF only include the DIF and DPF is not explained. Why was the SEF eliminated from consolidation?

3. Does the study identify all of the technical and cost impacts?

The study identified the technical and cost impacts that fall within the EDOS contract. It cited technical impacts to external systems and networks but did not attempt to estimate the cost impacts.

4. Does the study consider requirement changes that would be appropriate?

The study addresses requirement changes which are needed to reflect the consolidated facility but did not look for requirement changes which would offset the technical problems associated with a WVA CPF.

5. Are the answers valid? Can the derivation of the answers be validated?

The following table summarizes the elements of the study and the adequacy of the information presented in each area. A “no” does not mean that the study result is invalid. It means that the supporting information is inadequate to independently validate the results reported.

*EDOS IV&V Review of TRW Study 94-2
Facility Consolidation*

Study area	Information Adequacy
Architecture	Yes
Hardware	Yes
Software	No
External Interfaces	No
Internal Interfaces	Yes
Cost	No
Schedule	No
Facilities	Yes
Equipment Layouts	Yes
Requirements Modifications	No
Operations Concept	No
O&M Staffing	Yes

The study does not provide sufficient detail to defend many of the conclusions reached. It does not consider all the options or do trade studies in some areas where they are needed. This is specifically a problem in the WVA CPF option.

6. Should the study have addressed additional or different topics?

The possibility of consolidation of the SEF with the DIF and DPF should have been considered.

7. Does the study provide an adequate basis for NASA to make a selection?

Due to the lack of detail to support the results presented in the external interfaces and cost areas the study does not provide an adequate basis for decision making. Additionally, the Bent Pipe study (94-7) must be considered when making a decision on EDOS consolidation.